MR No. E5E12a

FEB 24 1947

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

WARTIME REPORT

ORIGINALLY ISSUED

May 1945 as
Memorandum Report E5E12a

THE EFFECT OF SIX AROMATIC AMINES ON THE PREIGNITION-LIMITED PERFORMANCE OF 28-R AVIATION FUEL IN A CFR ENGINE

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MEMORANDUM REPORT

for the

Army Air Forces, Air Technical Service Command

THE EFFECT OF SIX AROMATIC AMINES ON THE PREIGNITION-LIMITED PERFORMANCE OF 28-R AVIATION FUEL IN A CFR ENGINE

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INTRODUCTION

As a result of an investigation of the suitability of 45 aromatic amines as fuel additives, 6 of the most promising amines have been chosen on the basis of antiknock effectiveness, availability, and physical and chemical properties for knock tests in a full-scale single-cylinder engine and for preignition tests in a CFR engine. Blends of 28-R aviation fuel containing additions of 2 percent by weight of the following six aromatic amines were prepared and tested: xylidines, cumidines, N-methylxylidines, N-methylcumidines, N-methylaniline, and N-methyltoluidines. The results of the knock tests are presented in reference 1. The preignition tests were conducted at the NACA Cleveland laboratory in February 1945 and the results are presented herein.

APPARATUS AND TEST PROCEDURE

The tests were performed on a high-speed supercharged CFR engine coupled to a 25-horsepower, alternating-current, cradle-type dynamometer. The engine and its auxiliary equipment, which includes a four-hole cylinder head, a shrouded intake valve, two spark plugs, and an open-tube hot spot (source of preignition), are the same as the test setup described in reference 2.

The following engine conditions were maintained for the tests:

Compression ratio	7.0
Engine speed, rpm	1800
Spark advance, degrees B.T.C.	20
Inlet-air temperature, °F	225
Coolant temperature, °F	250
Oil temperature, °F	140

Inasmuch as the preignition-limited performance of the test fuels was not greatly different than that of 28-R, curves or check points for 28-R were determined both before and after each blend was tested. Any possible shift in the preignition-limited performance of the engine would therefore not be mistaken as a difference in the performance of the fuels being tested. The deviation of the data points from the faired curves was apparently the same as was shown for the data presented in reference 2.

After part of the tests was completed, the hot spot was filed shorter to remove a minute fracture that had formed on the end of the tube. The consequent increase in the preignition-limited performance of the hot spot as a result of this filing is apparent in the test results for 28-R. Data taken during the time this fracture was believed to have existed were discarded and the tests were rerun.

RESULTS AND DISCUSSION

The results of the tests are summarized in table I in the form of preignition-limited indicated mean effective pressures for the fuels tested and ratios of the preignition-limited indicated mean effective pressures of the six blends to that of 28-R aviation fuel. Because of the change in hot-spot length and small day-to-day variations in the preignition-limited performance of 28-R, specific comparisons of the test blends should be made on the basis of indicated mean effective pressure ratios rather than directly with the indicated mean effective pressures.

The results indicate that N-methylaniline and N-methylxylidines are the two safest antiknock additives with respect to preignition of the six aromatic amines tested. The preignition-limited performance of the fuels containing these amines agreed (within experimental error) with the preignition-limited performance of 28-R. For the fuel-air ratio range from 0.06 to 0.08, additions of cumidines, xylidines, N-methylcumidines, and N-methyltoluidines lowered the preignition-limited indicated mean effective pressure of 28-R from 2 to 10 percent. For the richer fuel-air ratios, 0.09 to 0.10, the only appreciable effect indicated was the lowering of the preignition-limited performance of 28-R by cumidines.

SUMMARY OF RESULTS

The results of the preignition tests of six aromatic amines conducted on a CFR engine indicate that N-methylaniline and N-methylxylidines had no appreciable effect on the preignition-limited performance of 28-R aviation fuel. For a fuel-air ratio range from 0.06 to 0.08 additions of cumidines, xylidines, N-methylcumidines, and N-methyltoluidines lowered the preignition-limited indicated mean effective pressure of 28-R aviation fuel from 2 to 10 percent.

Aircraft Engine Research Laboratory,
National Advisory Committee for Aeronautics,
Cleveland, Ohio, May 12, 1945.

REFERENCES

1. Jones, Anthony W., Bull, Arthur W., and Jonash, Edmund R.: Knock-Limited Performance of Six Aromatic Amines Blended with a Base Fuel in a Full-Scale Aircraft-Engine Cylinder. NACA MR No. E5D04, April 4, 1945.

2. Male, Donald W.: The Effect of Engine Variables on the Preignition-Limited Performance of Three Fuels. NACA TN No. 1131, 1946.

TABLE I. - PREIGNITION-LIMITED INDICATED MEAN EFFECTIVE PRESSURES FOR 28-R AND FOR SIX BLENDS OF 28-R CONTAINING AROMATIC AMINES

Aromatic amine (2-percent in 28-R aviation fuel)	Fuel-air ratio														
	0.06			0.07			0.08			0.09			0.10		
	imep of blend (lb/sq in.)	imep of 28-R (a)	imep ratio (b)	imep of blend (lb/sq in.)	imep of 28-R (a)	imep ratio (b)	imep of blend (lb/sq in.)	imep of 28-R (a)	imep ratio (b)	imep of blend (lb/sq in.)	imep of 28-R (a)	imep ratio (b)	imep of blend (lb/sq in.)	imep of 28-R (a)	imep ratio (b)
None (straight 28-R)	-------	----	1.00	-------	----	1.00	-------	----	1.00	-------	----	1.00	-------	----	1.00
Xylidines	110	115	.96	99	104	.95	109	114	.96	128	128	1.00	149	146	1.02
N-methyltoluidines	105	115	.91	97	105	.92	107	113	.94	122	126	.97	144	145	.99
M-methylcumidines	107	115	.92	95	105	.90	108	113	.96	122	126	.97	144	145	.99
Cumidines	119	122	.98	106	116	.91	118	130	.91	131	144	.91	149	164	.91
N-methylxylidines	121	124	.98	112	114	.98	127	129	.98	144	146	.99	165	165	1.00
N-methylaniline	126	124	1.02	112	114	.98	128	129	.99	145	146	.99	167	165	1.01

[a]imep of 28-R for corresponding test.

[b]Ratio of imep of blend to imep of 28-R for corresponding test.

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